STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EEM1026 – ENGINEERING MATHEMATICS II

(ME/ TE/ RE)

MARCH 2020

a.m. – a.m.

(2 Hours)

INSTRUCTIONS TO STUDENTS:

1. This exam paper consists of 4 **pages** (including cover page) with 4 Questions only.
2. Attempt all the questions. All questions carry equal marks and the distribution of marks for each question is given.
2. Please write all your answers in the Answer Booklet provided. Show all relevant steps to obtain maximum marks.
3. Only NON-PROGRAMMABLE calculator is allowed.

Question 1

(a) By using the method of undetermined coefficients, solve the following inhomogeneous differential equation.

$$y'' + 4y' + 4y = 8\sin 3x + 5x$$

[12 marks]

(b) Consider the solution of $y''-3xy'+2y=0$ in the form of power series in x about $x_0 = 0$, i.e., $y=\sum_{n=0}^{\infty} c_n x^n$. Find the first five nonzero terms of this series solution.

[13 marks]

Question 2

Consider a rod of length l coincides with the interval $[0,l]$ on the x-axis. The left end of the rod is held at zero temperature and the right end is insulated. The initial temperature is T_0 throughout.

(a) Set-up the initial boundary value problem for the temperature $u(x,t)$ for the above. [5 marks]

(b) Hence, by using the method of separation of variables and λ as the separation constant, find all possible solutions for Case *i*: $\lambda = p^2$, Case *ii*: $\lambda = -p^2$ and Case *iii*: $\lambda = 0$. [10 marks]

(c) From (b), by considering only solution for Case *ii*: $\lambda = -p^2$, show that

$$u(x,t)=\sum_{n=0}^{\infty}\frac{2T_0}{\left(n+\frac{1}{2}\right)\pi}e^{-\left(\frac{\left(n+\frac{1}{2}\right)\pi}{l}\right)^2 k^2 t}\sin\frac{\left(n+\frac{1}{2}\right)\pi}{l}x.$$

(Hint: if $\cos x = 0$, then $x=\left(n+\frac{1}{2}\right)\pi$, $n = 0,1,2,\ldots$) [10 marks]

Continued...

Question 3

(a) Solve the following initial-value problem by Laplace transform.

$y'' + 5y' + 6y = 4\cosh t,\ \ y(0) = 0$ and $y'(0) = 0.$ [13 marks]

(b) Find the Fourier transform of

$$f(x) = \begin{cases} 1+x, & -1 \le x \le 0 \\ 1-x, & 0 \le x \le 1 \\ 0, & otherwise. \end{cases}$$ [12 marks]

[Hint: Formula of Fourier transform is $F(w) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x)e^{-i\omega x}dx$]

Question 4

(a) An electrical company manufactures a plastic connector module that have depths that is approximately normally distributed with a standard deviation of 0.0015 inch.

(i) If a random sample of 75 modules has an average depth of 0.310 inch, find a 95% confidence interval for the mean of the depths of all connector modules produced by this company. [6 marks]

(ii) How large a sample is needed if we wish to be 95% confident that our sample mean will be within 0.0005 inch of the true mean? [3 marks]

(b) Ten bearings made by a certain process have a mean diameter of 0.5060 cm and a standard deviation of 0.0040 cm. Assuming that the data may be looked upon as a random sample from a normal population, construct a 95% confidence interval for the actual average diameter of bearings made by this process. [6 marks]

(c) The specifications for a certain kind of energy drink has an average sugar content of 14.0 grams. In an attempt to show that it differs from this value, a random sample of five energy drinks are selected from different cartons to measure its sugar content (grams per bottle).

14.6 14.4 14.3 14.5 14.2

Based on this sample, is the production under control?

Use a 0.05 level of significance and assume that the distribution of sugar content is normally distributed. [10 marks]

Continued...

APPENDIX

Table I: Laplace transform for some of function $f(t)$

$f(t)$	$F(s) = \mathcal{L}\{f(t)\} = \int_0^\infty e^{-st} f(t)\,dt$
1	$1/s$
t	$1/s^2$
$t^n (n = 1, 2, 3, \ldots)$	$n!/s^{n+1}$
e^{at}	$\dfrac{1}{s-a}$
te^{at}	$\dfrac{1}{(s-a)^2}$
$t^{n-1}e^{at}$	$\dfrac{(n-1)!}{(s-a)^n},\ n = 1,2,\ldots\ldots$
$\cos at$	$\dfrac{s}{s^2+a^2}$
$\sin at$	$\dfrac{a}{s^2+a^2}$
$\cosh at$	$\dfrac{s}{s^2-a^2}$
$\sinh at$	$\dfrac{a}{s^2-a^2}$
$u(t-a)$	$\dfrac{e^{-as}}{s},\ a \geq 0$
$f(t-a)\,u(t-a)$	$e^{-as} L(f)$
$f(t)\,\delta(t-a)$	$e^{-as} f(a)$
$f'(t)$	$s\mathcal{L}(f) - f(0)$
$f''(t)$	$s^2\mathcal{L}(f) - s f(0) - f'(0)$

End of paper.